gusts of shorter duration are also recognized. The accurate timing of single miles in such a record as that shown is, of course impossible, and the irregularity in the record caused by the registration of the passage of the "bridge" pin further limits refined measurements of the record simply to timing as accurately as possible the crests and hollows during the period of extreme velocities. In order to employ a method which would single out the greatest wind travel in a 5-minute period and which at the same time would be free from any personal bias, the writer chose the following: A standard millimeter scale was clamped down on a clear photographic copy of the record. The zero was placed at the noon line, and the scale alined parallel to the slope of the record, then with the aid of a piece of celluloid engraved with a fine transverse reference line, the scale readings given in table 3 were made of several crests and hollows before and after the place of maximum travel.

Table 3.—*Millimeter scale readings on crests and hollows of a portion of zig-zag wind trace like fig. 2 from noon to 12:30 p.m. Apr. 12*

Crest $N°$	Scale reading:	Diff. single 11 miles	Sums 22 miles	Hollow $N°$	Scale	Diff. single 11 miles	Sums 22 miles
0	1.9			.5	3.6		
1	5.1	3.2		1.5	6.6	3.0	
2	8.3	3.2	6.4	2.5	9.5	2.9	5.9
3	11.1	2.8	6.0	3.5	12.7	3.2	6.1
4	14.1	3.0	5.8	4.5	16.0	3.3	6.5
5	17.3	3.2	6.2	5.5	19.2	3.2	6.5
6	20.4	3.1	6.3	6.5	22.0	2.8	6.0
7	23.0	2.6	5.7	7.5	24.5	2.5	5.3
8	25.7	2.7	5.3	8.5	27.2	2.7	5.2
9	28.8	3.1	5.8	9.5	30.1	2.9	5.6
10	31.9	3.1	6.2	10.5	33.1	3.0	5.9
11	34.5	2.6	5.7	11.5	36.0	2.9	5.9
12	37.5	3.0	5.6	12.5	39.1	3.1	6.0
13	40.7	3.2	6.2	13.5	42.0	2.9	6.0
14	43.5	2.8	6.0	14.5	45.0	3.0	5.9
15	46.9	3.4	6.2	15.5	48.0	3.0	6.0

1 hour=65.1 mm. 5m=5.4 mm.

It is clear from the table that at the time of the maximum there was a sustained high movement represented by at least four double 22-mile groups having a time space ranging from 5.2, 5.3 up to 5.7 mm. Since a space of 5.4 mm. represents a time interval of 5 minutes, the maximum travel in 5 minutes must have ranged between at least 20.9 and at most 22.8 indicated miles, that is, 251 or 274 indicated miles per hour. By the November tests of 1933 (equation 6) these indicated speeds correspond to true hourly speeds of 184 and 199 miles per hour. By the June 1934 tests in the 3-foot tunnel (equation 7) the corresponding hourly movements are slightly higher, that is, 187 and 204 miles.

In the case of the still higher gusts timed by stopwatch, permitting reading time to hundredths of seconds, it is stated the shortest elapsed time was 1.17 seconds for an indicated travel of one-tenth mile, that is, 308 miles hourly movement, which corresponds to a true wind of 221 miles per hour by the November 1933 calibration, and 225 miles by the June 1934 test.

Great confidence is justified in the verity of these results, especially the 5-minute travel, because of the perfect character of the automatic record, the sustained movement during the maximum, the excellent fit of the hyperbolic equation to the test observations, and finally, the sound character of the extrapolation of corrections to extreme wind speeds.

FURTHER CONCLUSIONS FROM ADDITIONAL OBSERVATIONS IN THE FREE AIR OVER SAN DIEGO, CALIF.

By Dean Blake

[Weather Bureau, San Diego, Calif., 1934]

Because of their importance to aviation, their domination of climatic conditions in the regions affected, and the challenge they present, the fogs and overcast skies, and the concomitant temperature inversions that occur along the California coast during the summer, are the subject of considerable discussion and speculation. In spite of what has been written already, there remains a fruitful field open to research and investigation. Writers, too, are far from any sort of agreement as to their causes, and most of the conclusions that have been reached are based upon an insufficient amount of data.

This paper is in the nature of a supplementary discussion to others that have appeared, and is offered as an aid in the clearing up of some disputed points, by the presentation of additional data, made available through the courtesy of the aerological office at the Naval Air Station, San Diego, Calif. In it attempts are also made to couple various phases of the phenomena with the results of recent investigations, particularly with the findings from free air observations. With the accumulation of data, and the attainment of greater accuracy in aerological records, due largely to changes in technique, and an improvement in the aerographs in use, it has become possible to analyze many more statistics, and to draw much more accurate conclusions.

Several quite complete descriptions of the inversion and its attendant cloud stratum have been published, Byers, (1) and Anderson, (2) in particular, going into detail. All writers agree that it is a summer phenomenon limited to the littoral regions. It is characterized by the regular occurence of overcast skies during the greater part of the night and in the early morning; a decrease in temperature and an increase in relative humidity to the top of a relatively thin layer of air; and an increase in temperature and a rapid decrease in relative humidity for several hundred meters beyond, after which the normal lapse rate is approximated, and the humidity remains fairly constant but low.

The inland invasion of the vapor-laden stratum depends upon the elevation of the land contiguous to the ocean. Where a mountain range parallels the immediate coast without an opening, an effective barrier is offered, but where there are no elevations in its way, it penetrates well into the interior. Airways reports in San Diego County show that low clouds or fogs are prevalent in the early morning hours at least 40 miles inland, if there are no obstacles to prevent the sea breeze from carrying the moist air that far, but where mountains with an elevation of several thousand feet skirt the shore line, they are normally confined to the coastal areas.

The seaward extent is not definitely known, but Anderson states that it seems safe to assume that the stratus bank is usually unbroken for a distance of 200 to 300 miles.

There is ample proof that the cloud layer with an inversion above appears in the late spring or early summer, coincidentally with warm weather and the attendant thermal semi-permanent low pressure area over the Far Western interior. This year, for example, record-breaking high temperatures were recorded in the interior of southern California and the valleys of Arizona, as early as March, and, at the same time, low stratus developed along the southern coast, where the aerograms showed the anticipated rise in temperature above. Normally, though, no regularity of inversion conditions can be expected until June. May records show less than 50 percent of the days with inversions; June 76 percent; July 93 percent; and August 92 percent. In September the seasonal decrease in the number begins again. During several of the Julys and Augusts under consideration, every aerogram was of the inversion type.

Several explanations have been proposed. The first, by Thomas (**3**) in 1925, was to the effect that a form of convective circulation was in operation; a lower, moister layer of air coming from the ocean, with a higher, warmer counter-current finding its way westward across the mountains from the desert beyond, where it was supposed to have its origin in the intense heat. This idea still is held by many fliers.

Blake, with the help of Bowie (**4**) next offered the concept of a relatively cool stratum of moist air from the ocean overtopped by warmer air of continental origin brought in from great distances. In the paper an analysis was made of the data available up to that time.

Sometime later, Byers (**1**) expressed the conviction that "it is simply a case of cool, moist air making inroads into the warm air of the land", and "the warm air aloft is not brought in from the interior either directly or indirectly, but is the normal condition in the area."

Not content with the other explanations, Lieutenant Anderson (**2**) ascribed the formation of the cloud stratum to the action of turbulence. He asserts in his paper that the water of the Pacific ocean everywhere is warmer than at any given point along California. Thus, as the air moves toward the land, it must pass over colder and colder water, and in its passage the surface layers become cooled. Due to friction between the air and the water, the air becomes turbulent, and through energy supplied by the wind, eddies are formed which mix the colder surface air with the warmer air above. In this way the temperature of the stratum decreases with altitude up to the base of the inversion, the height of which depends upon the wind force, temperature and humidity.

Of the causes of the inversion, he is of the opinion that any mass of air approaching the coast from a considerable distance at sea must develop an inversion. If clouds do not develop, the lapse rate of the air near the coast would be approximately equal to the dry adiabatic up to the top of the stratum, but above that point the temperature would increase, with the maximum at some point, say, 1,000 feet higher. Thus, in Anderson's opinion, the inversion is a sea condition caused by the cold water along the coast.

As these deductions are based on the premise that practically all of the air over the coastal region, regardless of its altitude, comes from the ocean, it will profit us to look into the accuracy of the data from which they have been drawn.

It is unfortunate that both Byers and Anderson laid so much stress on the summary of pilot-balloon soundings for June, July, and August, 1924–27, published in the writer's article previously referred to. Table 1, which is based on more recent data, is offered for consideration, and shows considerable variation from the summarization of the earlier period. It presents the number of times at the San Diego Airport Station, during July and August 1933 that the wind was observed from each of the 16 directions at elevations to 10,000 meters. In it, the sea breeze (SW. to NNW.) is found to prevail to 1,000 meters, but above this elevation there is a backing toward the directions between the south and the east, with the change from the westerly quadrant to the southerly quite abrupt. A significant feature is that even in the highest altitudes no return to the western sector is apparent.

That the results in the table are in no way abnormal, is borne out by the wind roses, for San Diego and Los Angeles, on the Pilot Chart of the Upper Air for the North Pacific Ocean, for July and August, which graphically present over a period of several years at the 10,000-foot level (3,000 meters), the same preponderance of directions from land sources.

If a further check of the accuracy of table 1 is needed, it is presented in table 2, the movements of the upper and intermediate clouds at San Diego during July and August in the last 7 years. The omission of alto-stratus clouds from the table is due to their rare occurrence.

Granting its prevalency, the source of this upper-air movement is not hard to find. In a convincing paper by T. R. Reed, in the MONTHLY WEATHER REVIEW for November 1933 (**5**) the existence of an anticyclonic circulation, in the upper levels over southwestern United States and northern Mexico during the warm season, was conclusively demonstrated, its western rim embracing the California coast. This paper leaves little doubt that, as a rule, winds aloft over San Diego, coming from directions between the east and southwest during the summer months, belong to this great, upper wind system that covers all of the southwestern portion of the north American continent, and that, in their broad, clockwise movement, may have traversed the Mexican highlands, but in any event have been warmed by subsidence en route.

A day-to-day study of the aerograms, received in the San Diego office from the Naval Air Station, soon convinced us that some hastily formed, but generally accepted, conclusions were not substantiated, so a tabulation and analysis was made of all observations with inversions of temperature in June, July, and August during the 5 years, 1929–33. A summarization of these data is found in tables 3 to 6.

In passing, it may be remarked that it always has been assumed that the top of the cold moist layer coincides with the point of lowest temperature and highest relative humidity, regardless of whether or not clouds are visible. While some discrepancies occasionally appear between the elevations observed and those indicated by the aerograph traces, they are not too large to be ascribed to instrumental error or lag.

THE COLD MOIST STRATUM

In the consideration of the tables and othere data at hand, several points are found worthy of enumeration.

1. Published opinions to the contrary, notwithstanding, the top of the stratum does not remain at the same height during any given occurrence, but is subject to

marked changes in the 24 hours. Table 3 conclusively shows that it is lowest in the afternoon and highest in the morning, with an average change in elevation of 102 meters (335 feet). That this variation is not an error resulting from the use of a mean derived from separate and differing sets of readings, is verified by the results given in table 4, data for days with two aerograms, one at 8 a.m., and one at 1 p.m. The agreement between the two sets is too close to be accidental. Furthermore, this change in the height of the top of the stratum has been found to occur on days completely overcast, on two occasions the afternoon showing a drop of over 300 meters (1,100 feet).

It may be remarked here that assertions are frequently but loosely made, that if the height of the top of the moist layer has been established at one point in southern California, say at Mount Wilson, that it will have the same elevation everywhere else in the district. This is not so. Careful observations by Army pilots show a difference of several hundred meters between the coast in the Los Angeles area and the San Fernando Valley, a gradual increase taking place with increase of distance inland.

2. The thickness of the layer changes considerably from day to day, and, as the top rises or falls there is a corresponding rise or fall in the ceiling below a large part of the time. In other words, a lowering of the ceiling usually is accompanied by a dropping of the top of the cloud. Surface fogs generally occur when the elevation of the top is below the average thickness of the stratum. From this we are convinced that one of the most promising methods of solving the appearance of summer fogs at the surface, is to determine the controlling factors in the height of the cold moist layer.

3. The height of the stratum tends to follow in a converse manner the mean temperature curve for valley stations in San Diego County; that is, it is lowest when the temperature is highest. This is shown graphically in figure 1. The same correspondence is noted with the same curve drawn for desert stations to the east, but is less pronounced.

4. Cloud ceilings at coastal stations almost invariably rise just before the sky clears. Dissipation, as a rule, first begins inland, and works its way to the coast, where a cloud bank can be seen at sea during the balance of the day. After sunset, clouds form again quite suddenly, and, as the formation gradually progresses toward the interior, the ceiling drops slowly, reaching the minimum in the hours around sunrise. It is most significant that clouds often appear several miles inland before they begin to overspread the littoral. The statement by Varney (*6*) that dissipation of the "high fog" proceeds very largely from the top downward in the piedmont littoral of Los Angeles, is not in accord with observations at San Diego.

5. The moist stratum is rendered visible (when clouds are not present) by a haze layer which extends to the ground. Above this, smoke and dust do not penetrate, and visibility, normally, is unlimited. On numerous occasions, clouds actually have been observed in the process of formation at the top of the haze. Invariably they built downward, and in their disappearance invariably began to dissolve at the bottom. That they occasionally grow upward and dissipate downward is probable, but a "burning off" from the top to the bottom has never been witnessed by the personnel at the San Diego offices.

We believe that the conclusions reached by Bowie in his paper "The Summer Nighttime Clouds of the Santa Clara Valley, Calif. (*7*) cover and explain the formation of the stratus clouds of summer at San Diego as well as in the San Francisco Bay region.[1]

That turbulence is found in the moist air is evident. The cloud shows it, aviators experience it, and the uneven top of the stratum verifies its existence. But the assumption that such turbulence is the effect of advective processes is refuted by the fact that the turbulence reaches its maximum after horizontal wind movement has practically ceased. By the tables the top of the stratum is proved to be actually several hundred feet lower during the warmest and windiest hours than it is during the quiet morning hours. Furthermore, turbulence which results from advection in a stable air mass cannot produce an unstable lapse rate, whereas radiation from the superior surface of such a mass not only can but continually does, with turbulence as a consistent and inevitable consequence.

It may be well here to point out that the role played by advective turbulence in the formation of advection fog, found at all seasons on the California coast, is fully recognized, and not minimized in the least. It is further realized that fogs of this type spread over the land at times. However, in this paper we are concerned solely with the so-called "high fog", the formation of which is believed to be by nocturnal radiation from the top of the cold stratum, with the growth of the cloud taking place downward.

We cannot believe, furthermore, that a cloud layer which penetrates, and upon occasion actually forms many miles inland, depends entirely upon the action of wind and wave for its origin. The very fact that its dissipation is from the bottom up, and its formation from the top down, should eliminate any explanation that involves the initial cooling at or near ground level.

Surface turbulence, if further argument is needed, would tend to prevent stratification rather than give rise to it. Under no circumstances could it cause a mass of air to rise to a uniform level over an area of several hundred square miles, particularly when surface elevations vary greatly, and different temperature and pressure gradients, moisture content, and wind velocities obtain.

THE INVERSION LAYER

A brief description of the salient features of the inversion layer remains to be given, so, in addition to the data offered in tables 5 and 6, the following summing up is presented.

1. The temperature inversion persists both day and night, but there is no regular diurnal maximum and minimum temperature. The mean change between the

[1] The essence of Bowie's theory it found in the following quotation taken verbatim from the paper in question: "It is known that air rich in water vapor is selectively highly absorptive of terrestrial long-wave-length radiation; and being a good absorber it also is a good radiator in the same spectral region, in fact as good, nearly as a black body. Conversely, dry, clear air is diathermanous to terrestrial of long-wave-length radiation and therefore in that region a nonradiator, and its temperature subject to change only by work done by it or upon it. Hence at night the stratum of marine air rich in water vapor cools radiationally while the stratum of dry air above it remains at a constant temperature or, at most, loses its heat very slowly. * * * When this situation exists the excess of outgoing over incoming radiation is at its maximum at the upper surface of the bay of marine air, and sometime during the night the cooling thus caused reaches the dew point, condensation starts and cloud forms. It does not necessarily follow that the dew point is reached first at the upper surface of the humid air; it may be at some intermediate altitude between this surface and the bottom. When the dew point is reached at the upper surface first, the growth of the cloud is downward; whereas when it is reached first at an intermediate altitude the growth of the cloud is both upward and downward. Ultimately the cooling throughout the marine air, from a maximum at its upper surface downward to a minimum at its bottom, may result in the lapse rate exceeding the adiabatic, when there will follow convection and turbulence that would cause a pilot passing through or under the cloud to experience bumpiness. This convective turbulence increases the rapidity of cloud formation. The descending currents, the counterpart of the ascending currents in the convective process, are not heated at the adiabatic rate for dry air, for in them there is loss of heat by evaporation, the equivalent of that gain by condensation in the ascending current. As the cooling proceeds the thickness of the cloud increases and at times the entire mass of marine air is filled with cloud from top to bottom."

morning and afternoon, as shown in table 6, is only 0.2° C. with the afternoon readings higher only 55 percent of the time. In August, mornings were actually warmer than afternoons.

2. The height of the maximum inversion varies from morning to afternoon and from day to day, and the change in elevation, while independent of the upper surface of the cold stratum, is similar in that it is usually lower in the afternoon than in the morning.

3. Apparently there is no relation between wind direction and the highest temperature found aloft; the winds are generally light and variable.

4. Warm weather at ground stations is often accompanied by a rise in temperature in the upper air at the same time unless convectional overturning results, and the inversion is displaced. However, a warm summer at the surface does not signify a similar condition aloft. For example, in the records for San Diego County, the summer of 1931 was abnormally warm, yet inversion temperatures averaged the lowest of the five summers under consideration.

5. Temperatures in the upper air have not proved to be as high as reputed. Above 90° F. was recorded twice only in the last five summers, and maxima over 85° F. were registered only infrequently. The absolute highest for the period was 92° F. on July 26, 1933; also the warmest day of the month at surface stations.

From these data and arguments, we are convinced that the cold stratum is of marine origin, and the inversion is of continental origin, the direct cause of high temperatures aloft usually being subsidence of air brought in by the thermal high-level anticyclone. The two strata are fundamentally different, and like a layer of oil on a layer of water—they will not mix.[2]

What may be taken as visible proof of the immiscibleness of the two strata was witnessed recently near Los Angeles. Black smoke from a burning oil well rose as a huge dome several hundred feet into the inversion layer, but was unable to penetrate it, the smoke surrounding the dome settling along and outlining the top of the cold stratum. Directly over the fire, however, thermal convection was of sufficient strength to make the dome of smoke-filled air. The whole formation appeared as though an invisible lid was establishing definite ascensional limits.

Sailplanes and gliders, according to pilots, cannot rise beyond the upper surface of the marine air. Lange (8) explains this by the principle that "temperature inversions resist the vertical air exchange, and generally retard the vertical velocities completely."

The inversion problem is more than local. In his paper on fog and haze, Willett, (**9**) on page 448, remarks that Georgii and many others have pointed out that inversions commonly found above "high fog" are the surfaces of subsidence in anticyclones. Now that logical sources for the descending currents have been discovered, the explanation of the phenomena on the California coast is apparent.

[2] On the margin of the manuscript, T. R. Reed made the following annotation: "Any air mass, which has undergone subsidence, might conceivably supply the source. All meteorologists agree that there is subsidence in the antitrades, so it would not be hard to imagine at times a marked settling of tropical air anywhere in these latitudes, perhaps accentuated in this vicinity by the cold waters found off our coast. Furthermore, it is conceivable that air in its vast clockwise trajectory around the Pacific high area may have its source far to the south, and reach the California coast as a relatively warm northwest or west wind, which has become dry and has gained additional heat in its descent."

How else, except by dynamically heated descending air, are we able to account for the excessively low relative humidity readings that occurred in June 1932 over San Diego, when the aerograph recorded 0 percent at all levels from 8,000 to 11,000 feet with westerly winds prevailing? (**10**).

As a rule winds in the lower levels of the inversion are from the direction of the ocean. This, to many, is a serious objection to the subsidence theory. An analogous situation and a logical explanation may be cited in the weather at San Diego where high temperatures generally occur with winds coming directly from the water; yet the relative humidity may be extremely low, and strong east and northeast winds may be blowing at the 300- or 500-meter level. It is not improbable that a similar condition obtains in the inversion canopy, where light east to southwest winds prevail above the 2,000-meter plane, and the sea breeze in variable depths below. Even if winds are from the ocean at the point of maximum inversion, they still may convey the hot dry air of the 4,000- or 4,500-meter levels.

Byer's suggestion that warm air of the inversion layer is not brought in either from the interior or the ocean, but is a normal condition in the air, yet remains to be considered. This explanation must be dismissed on the grounds that no diurnal change is apparent, and the highest daily readings are recorded in the morning almost as often as the afternoon. If temperatures in this layer were normal, as contended, the normal lapse rate above the moist stratum would be closely approximated because the impenetrability of the inversion layer precludes mixing from below to any degree. Moreover, temperatures in the inversion layer have been found to be independent of terrestrial radiation, and are not affected by high or intermediate cloudiness that materially lowers surface readings.

Several fellow workers, whose assistance is gratefully acknowledged here, raised a query as to why the temperature peak is so far above the lower stratum. In the tables submitted its average height is 1,248 meters (4,100 feet), which places it 746 meters (2,450 feet) above the cold stratum. If our deductions have been correct, the highest readings should occur at the level of maximum subsidence some distance above the base of the inversion, leaving an air mass of varying thickness which would tend to damp out descent in the lower levels of the inversion. It is found at the most logical place. The source of the variation in height, temperature and humidity of the whole upper layer is found in the strength, depth, origin, and water vapor content of the air stream from which its very existence is obtained.

Our conclusions, then, briefly summed up are as follows:

1. The underlying cool moist stratum is of maritime origin. Clouds form along the top by radiation, usually in the early evening, and as night advances, build downward. In the morning, dissipation begins at the bottom and works upward.

2. The overlying warm dry stratum, known as the inversion layer, is usually the result of subsidence of air from the interior of the continent, brought to the California coast by the high-level anticyclone, centered over the heated regions to the eastward.

TABLE 1.—*Summary of pilot-balloon ascensions at San Diego, Calif., during July and August 1933. Observations at 3:30 p.m., P.S.T.*

[Meters]

Direction	Surface	250	500	750	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	5,000	6,000	7,000	8,000	9,000	10,000
N	--	--	1	1	3	2	1	3	2	1	1	--	--	--	--	--	--	--
NNE	--	--	1	--	--	--	1	--	1	--	--	--	--	--	--	--	--	--
NE	--	--	1	1	--	2	3	--	--	1	--	--	2	2	--	--	1	1
ENE	--	--	--	--	--	1	2	4	1	2	2	1	1	1	1	1	1	1
E	--	--	--	1	--	--	3	2	5	4	5	5	6	3	3	4	1	--
ESE	--	--	--	1	--	1	3	5	5	3	2	2	--	1	3	1	1	2
SE	--	1	--	2	1	--	5	7	6	7	3	4	3	3	--	--	1	--
SSE	--	1	--	6	3	8	5	6	3	5	5	4	6	1	1	1	--	--
S	7	1	8	5	8	6	6	5	5	6	8	6	4	5	1	--	2	1
SSW	5	7	5	2	4	1	2	5	8	3	4	4	6	5	2	--	--	--
SW	7	10	5	3	1	5	5	3	2	5	3	5	1	1	2	4	2	--
WSW	4	1	4	3	2	5	3	1	4	3	6	2	3	3	1	1	1	1
W	13	8	7	3	5	3	3	4	1	2	4	6	4	2	--	--	--	--
WNW	16	18	8	6	6	3	1	2	1	1	--	--	--	2	--	--	--	--
NW	10	14	14	11	13	7	3	--	1	1	--	1	--	--	--	1	1	1
NNW	--	1	6	10	7	6	4	1	--	--	--	--	3	1	--	--	--	--
CALM	--	--	--	--	--	1	--	--	1	--	--	--	--	--	--	--	--	--

NOTE.—Soundings during June were made at 8:30 p.m., P.S.T., usually after clouds had formed, and few reached a greater height than 1,500 meters, and none over 5,000 meters.

TABLE 2.—*Percentage of times upper and intermediate clouds were recorded from various directions at San Diego, Calif., during July and August 1927–33*

	Ci.	Ci. St.	Ci. Cu.	A. Cu.
N	1	1	0	0
NE	2	4	2	3
E	15	27	18	25
SE	31	42	46	49
S	18	18	25	15
SW	15	0	2	4
W	7	2	0	0
NW	1	0	0	0
CALM	10	7	7	4
Number of observations	107	45	44	194

NOTE.—Those reported calm were usually on the southern or eastern horizon, and were too distant for the direction to be determined.

TABLE 3.—*Average height, mean temperature, and relative humidity at the top of the cold stratum during June, July, and August 1929–33, inclusive, for all observations*

Month	Number		Average height		Temperature		Relative humidity	
	A.m.	P.m.	A.m.	P.m.	A.m.	P.m.	A.m.	P.m.
			Meter	*Meters*	°*C.*	°*C.*	*Per-cent*	*Per-cent*
June	72	45	641	529	13.7	14.1	88	85
July	96	60	514	457	17.2	17.7	90	85
August	103	63	496	413	17.9	19.3	90	75
Total	271	168						
Average			545	460	16.5	17.2	90	83

TABLE 4.—*Average height, mean temperature and relative humidity at the top of the cold stratum during June, July, and August 1929–33, inclusive. For a.m. and p.m. observations made the same day.*

Month	Number	Average height		Temperature		Relative humidity	
		A.m.	P.m.	A.m.	P.m.	A.m.	P.m.
		Meters	*Meters*	°*C.*	°*C.*	*Percent*	*Percent*
June	36	672	544	13.3	14.1	89	85
July	56	559	454	16.3	17.7	92	85
August	60	502	419	17.3	18.6	91	81
Total	152						
Average		563	461	16.0	17.2	91	83

TABLE 5.—*Average height, mean temperature, and relative humidity of the point of highest temperature during June, July, and August, 1929–33, inclusive. For all observations*

Month	Number		Average height		Temperature		Relative humidity	
	A.m.	P.m.	A.m.	P.m.	A.m.	P.m.	A.m.	P.m.
			Meters	*Meters*	° *C.*	° *C.*	*Pct.*	*Pct.*
June	72	45	1,449	1,236	20.9	21.2	26	28
July	96	61	1,297	1,289	25.0	25.2	31	32
August	103	64	1,181	1,094	24.8	25.1	34	34
Total	271	170						
Average			1,293	1,202	23.8	24.1	30	32

TABLE 6.—*Average height, mean temperature, and relative humidity of the point of highest temperature during June, July, and August, 1929–33, inclusive. For a.m. and p.m. observations made the same day*

Month	Number	Average height		Temperature		Relative humidity	
		A.m.	P.m.	A.m.	P.m.	A.m.	P.m.
		Meters	*Meters*	° *C.*	° *C.*	*Percent*	*Percent*
June	36	1,445	1,253	20.6	20.7	25	28
July	54	1,332	1,270	24.7	25.1	31	31
August	60	1,164	1,101	24.9	24.8	33	35
Total	150						
Average		1,292	1,192	23.8	24.0	30	32

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